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STUDY OF SOLID ROCKET MOTORS FOR A SPACE SHUTTLE BOOSTER

FINAL REPORT

(NASA-CR-123621) STUDY OF SOLID ROCKET
MOTORS FOR A SPACE SHUTTLE BOOSTER.

APPENDIX A: SOLID ROCKET MOTOR PROGRAM
COST ESTIMATE Final (United Technology
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APPENDIX A SOLID ROCKET MOTOR PROGRAM COST ESTIMATE

PROPRIETARY INFORMATION



United Technology Center

DIVISION OF UNITED AIRCRAFT CORPORATION

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**STUDY OF
SOLID ROCKET MOTORS
FOR A SPACE SHUTTLE BOOSTER
FINAL REPORT**

APPENDIX A
SOLID ROCKET MOTOR
PROGRAM COST ESTIMATE

15 March 1972

Prepared Under
Contract NAS8-28431
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for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA

by

United Technology Center



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1970 DOLLARS IN MILLIONS

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION S6-120
PEAK LAUNCH RATE: 10/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	16.068					16.068	50.363		66.431
03.02.00.00	Systems engineering	9.503					9.503	13.194	4.594	27.291
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			1.407	3.718		5.125	39.498		44.623
03.03.02.01	Motor case and propellant			18.098	33.455		51.553	464.427		515.980
03.03.02.02	Nozzle			7.384	9.120		16.504	125.559		142.063
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.272	2.698		2.970	38.500		41.470
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.851	2.022		2.873	32.277		35.150
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.761	4.918		7.679	73.196		80.875
03.03.02.06	Thrust termination			.273	1.149		1.422	17.749		19.171
03.03.02.07	Structures			4.740	12.476		17.216	164.018		181.234
03.03.02.00	Subtotal SRM structures			34.379	65.838		100.217	915.726		1015.943
03.03.00.00	Subtotal SRM aerospace vehicle equipment			35.786	69.556		105.342	955.224		1060.566
03.04.00.00	Facilities (activation)				3.359		3.359			3.359
03.05.00.00	System support			.735	2.338	12.460	15.533	128.784	57.536	201.853
03.06.00.00	Ground test	2.658	4.036	5.701			12.395			12.395
03.07.00.00	Flight operations				6.903		6.903		44.446	51.349
03.00.00.00	Total program	28.229	4.036	42.222	82.156	12.460	169.103	1147.565	106.576	1423.244

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CONFIGURATION S6-120
PEAK LAUNCH RATE: 20/YR.

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total		
03.01.00.00	Program management	16.068					16.068		71.286
03.02.00.00	Systems engineering	9.503					9.503	5.288	39.042
	Aerospace vehicle equipment								
03.03.01.00	Cluster/interstage SRM structure			1.407	3.718		5.125	65.619	70.744
03.03.02.01	Motor case and propellant			18.098	33.455		51.553	893.958	945.511
03.03.02.02	Nozzle			7.384	9.120		16.504	241.428	257.932
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.272	2.698		2.970	74.798	77.768
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.851	2.022		2.873	62.425	65.298
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.761	4.918		7.679	139.860	147.539
03.03.02.06	Thrust termination			.273	1.149		1.422	34.047	35.469
03.03.02.07	Structures			4.740	12.476		17.216	290.942	308.158
03.03.02.00	Subtotal SRM structures			34.379	65.838		100.217	1737.458	1837.675
03.03.00.00	Subtotal SRM aerospace vehicle equipment			35.786	69.556		105.342	1803.077	1908.419
03.04.00.00	Facilities (activation)				3.359		3.359		3.359
03.05.00.00	System support			.735	2.338	12.460	15.533	236.903	365.355
03.06.00.00	Ground test	2.658	4.036	5.701			12.395		12.395
03.07.00.00	Flight operations				6.903		6.903	84.208	91.111
03.00.00.00	Total program	28.229	4.036	42.222	82.156	12.460	169.103	2119.449	2490.967

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION S6-120
PEAK LAUNCH RATE: 40/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	16.068					16.068	58.193		74.261
03.02.00.00	Systems engineering	9.503					9.503	39.818	6.423	55.744
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			1.407	3.718		5.125	109.056		114.181
03.03.02.01	Motor case and propellant			18.098	33.455		51.553	1582.432		1633.985
03.03.02.02	Nozzle			7.384	9.120		16.504	424.945		441.449
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.272	2.698		2.970	135.380		138.350
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.851	2.022		2.873	109.515		112.388
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.761	4.918		7.679	246.956		254.635
03.03.02.06	Thrust termination			.273	1.149		1.422	60.261		61.683
03.03.02.07	Structures			4.740	12.476		17.216	489.816		507.032
03.03.02.00	Subtotal SRM structures			34.379	65.838		100.217	3049.305		3149.522
03.03.00.00	Subtotal SRM aerospace vehicle equipment			35.786	69.556		105.342	3158.361		3263.703
03.04.00.00	Facilities (activation)				3.359		3.359			3.359
03.05.00.00	System support			.735	2.338	12.460	15.533	394.539	130.297	540.369
03.06.00.00	Ground test	2.658	4.036	5.701			12.395			12.395
03.07.00.00	Flight operations				6.903		6.903		150.894	157.797
03.00.00.00	Total program	28.229	4.036	42.222	82.156	12.460	169.103	3650.911	287.614	4107.628

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION S6-120
PEAK LAUNCH RATE: 60/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	16.068					16.068	63.504		79.572
03.02.00.00	Systems engineering	9.503					9.503	45.844	7.917	63.264
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			1.407	3.718		5.125	131.127		136.252
03.03.02.01	Motor case and propellant			18.098	33.455		51.553	1969.570		2021.123
03.03.02.02	Nozzle			7.384	9.120		16.504	529.607		546.111
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.272	2.698		2.970	169.520		172.490
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.851	2.022		2.873	136.930		139.803
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.761	4.918		7.679	305.380		313.059
03.03.02.06	Thrust termination			.273	1.149		1.422	73.631		75.053
03.03.02.07	Structures			4.740	12.476		17.216	590.891		608.107
03.03.02.00	Subtotal SRM structures			34.379	65.838		100.217	3775.529		3875.746
03.03.00.00	Subtotal SRM aerospace vehicle equipment			35.786	69.556		105.342	3906.656		4011.998
03.04.00.00	Facilities (activation)				3.359		3.359			3.359
03.05.00.00	System support			.735	2.338	12.460	15.533	482.277	145.480	643.290
03.06.00.00	Ground test	2.658	4.036	5.701			12.395			12.395
03.07.00.00	Flight operations				6.903		6.903		186.207	193.110
03.00.00.00	Total program	28.229	4.036	42.222	82.156	12.460	169.103	4498.281	339.604	5006.988

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FOLDOUT FRAME 1

FOLDOUT FRAME 2

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

CONFIGURATION S3-156
PEAK LAUNCH RATE: 10/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	13.801					13.801	27.317		41.118
03.02.00.00	Systems engineering	15.712					15.712	8.935	5.249	29.896
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.594	3.126		3.720	40.830		44.550
03.03.02.01	Motor case and propellant			33.831	29.952		63.783	438.283		502.066
03.03.02.02	Nozzle			10.258	7.382		17.640	116.356		133.996
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.337	2.183		2.520	28.316		30.836
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.979	1.117		2.096	17.946		20.042
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.748	2.446		5.194	38.274		43.468
03.03.02.06	Thrust termination			.236	.740		.976	11.997		12.973
03.03.02.07	Structures			4.727	11.831		16.558	158.814		175.372
03.03.02.00	Subtotal SRM structures			53.116	55.651		108.767	809.986		918.753
03.03.00.00	Subtotal SRM aerospace vehicle equipment			53.710	58.777		112.487	850.816		963.303
03.04.00.00	Facilities (activation)				2.709		2.709			2.709
03.05.00.00	System support			.872	3.251	9.139	13.262	100.512	56.629	170.403
03.06.00.00	Ground test	8.464	29.021	9.627			47.112			47.112
03.07.00.00	Flight operations				5.109		5.109		25.732	30.841
03.00.00.00	Total program	37.977	29.021	64.209	69.846	9.139	210.192	987.580	87.610	1285.382

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION S3-156

PEAK LAUNCH RATE: 20/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	13.801					13.801	30.272		44.073
03.02.00.00	Systems engineering	15.712					15.712	15.916	6.572	38.200
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.594	3.126		3.720	70.257		73.977
03.03.02.01	Motor case and propellant			33.831	29.952		63.783	837.173		900.956
03.03.02.02	Nozzle			10.258	7.382		17.640	223.763		241.403
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.337	2.183		2.520	52.901		55.421
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.979	1.117		2.096	34.421		36.517
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.748	2.446		5.194	73.210		78.404
03.03.02.06	Thrust termination			.236	.740		.976	22.799		23.775
03.03.02.07	Structures			4.727	11.831		16.558	283.071		299.629
03.03.02.00	Subtotal SRM structures			53.116	55.651		108.767	1527.338		1636.105
03.03.00.00	Subtotal SRM aerospace vehicle equipment			53.710	58.777		112.487	1597.595		1710.082
03.04.00.00	Facilities (activation)				2.709		2.709			2.709
03.05.00.00	System support			.872	3.251	9.139	13.262	173.266	107.325	293.853
03.06.00.00	Ground test	8.464	29.021	9.627			47.112			47.112
03.07.00.00	Flight operations				5.109		5.109		46.873	51.982
03.00.00.00	Total program	37.977	29.021	64.209	69.846	9.139	210.192	1817.049	160.770	2188.011

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

CONFIGURATION S3-156

PEAK LAUNCH RATE: 40/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	13.801					13.801	34.238		48.039
03.02.00.00	Systems engineering	15.712					15.712	27.271	7.222	50.205
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.594	3.126		3.720	120.798		124.518
03.03.02.01	Motor case and propellant			33.831	29.952		63.783	1474.245		1538.028
03.03.02.02	Nozzle			10.258	7.382		17.640	395.173		412.813
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.337	2.183		2.520	91.022		93.542
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.979	1.117		2.096	60.464		62.560
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.748	2.446		5.194	127.288		132.482
03.03.02.06	Thrust termination			.236	.740		.976	39.535		40.511
03.03.02.07	Structures			4.727	11.831		16.558	467.541		484.099
03.03.02.00	Subtotal SRM structures			53.116	55.651		108.767	2655.268		2764.035
03.03.00.00	Subtotal SRM aerospace vehicle equipment			53.710	58.777		112.487	2776.066		2888.553
03.04.00.00	Facilities (activation)				2.709		2.709			2.709
03.05.00.00	System support			.872	3.251	9.139	13.262	289.826	125.502	428.590
03.06.00.00	Ground test	8.464	29.021	9.627			47.112			47.112
03.07.00.00	Flight operations				5.109		5.109		79.806	84.915
03.00.00.00	Total program	37.977	29.021	64.209	69.846	9.139	210.192	3127.401	212.530	3550.123

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION S3-156
PEAK LAUNCH RATE: 60/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	13.801					13.801	37.326		51.127
03.02.00.00	Systems engineering	15.712					15.712	34.096	8.877	58.685
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.594	3.126		3.720	151.027		154.747
03.03.02.01	Motor case and propellant			33.831	29.952		63.783	1793.954		1857.737
03.03.02.02	Nozzle			10.258	7.382		17.640	492.391		510.031
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.337	2.183		2.520	112.039		114.559
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.979	1.117		2.096	75.597		77.693
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.748	2.446		5.194	159.112		164.306
03.03.02.06	Thrust termination			.236	.740		.976	49.412		50.388
03.03.02.07	Structures			4.727	11.831		16.558	560.984		577.542
03.03.02.00	Subtotal SRM structures			53.116	55.651		108.767	3243.489		3352.256
03.03.00.00	Subtotal SRM aerospace vehicle equipment			53.710	58.777		112.487	3394.516		3507.003
03.04.00.00	Facilities (activation)				2.709		2.709			2.709
03.05.00.00	System support			.872	3.251	9.139	13.262	361.972	138.553	513.787
03.06.00.00	Ground test	8.464	29.021	9.627			47.112			47.112
03.07.00.00	Flight operations				5.109		5.109		97.098	102.207
03.00.00.00	Total program	37.977	29.021	64.209	69.846	9.139	210.192	3827.910	244.528	4282.630

CONFIGURATION P4-120
PEAK LAUNCH RATE: 10/YR.

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	14.409					14.409	50.695		65.104
03.02.00.00	Systems engineering	9.095					9.095	10.178	5.105	24.378
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			12.756	22.312		35.068	327.455		362.523
03.03.02.02	Nozzle			6.340	6.050		12.390	88.142		100.532
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.231	2.071		2.302	32.759		35.061
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.731	1.363		2.094	22.512		24.606
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.253	3.306		5.559	51.146		56.705
03.03.02.06	Thrust termination			.217	.766		.983	12.156		13.139
03.03.02.07	Structures			2.925	8.313		11.238	124.043		135.281
03.03.02.00	Subtotal SRM structures			25.453	44.181		69.634	658.213		727.847
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.934		2.934			2.934
03.05.00.00	System support			.734	1.980	7.382	10.096	103.330	41.725	155.151
03.06.00.00	Ground test	2.658	4.036	5.292			11.986			11.986
03.07.00.00	Flight operations				5.070		5.070		32.845	37.915
03.00.00.00	Total program	26.162	4.036	31.479	54.165	7.382	123.224	822.416	79.675	1025.315

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION P4-120
PEAK LAUNCH RATE: 20/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	14.409					14.409	53.035		67.444
03.02.00.00	Systems engineering	9.095					9.095	18.063	6.490	33.648
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			12.756	22.312		35.068	623.263		658.331
03.03.02.02	Nozzle			6.340	6.050		12.390	166.962		179.352
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.231	2.071		2.302	63.772		66.074
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.731	1.363		2.094	43.163		45.257
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.253	3.306		5.559	97.311		102.870
03.03.02.06	Thrust termination			.217	.766		.983	23.554		24.537
03.03.02.07	Structures			2.925	8.313		11.238	220.404		231.642
03.03.02.00	Subtotal SRM structures			25.453	44.181		69.634	1238.429		1308.063
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.934		2.934			2.934
03.05.00.00	System support			.734	1.980	7.382	10.096	178.455	77.450	266.001
03.06.00.00	Ground test	2.658	4.036	5.292			11.986			11.986
03.07.00.00	Flight operations				5.070		5.070		56.767	61.837
03.00.00.00	Total program	26.162	4.036	31.479	54.165	7.382	123.224	1487.982	140.707	1751.913

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CONFIGURATION P4-120
PEAK LAUNCH RATE: 40/YR.

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	14.409					14.409	53.967		68.376
03.02.00.00	Systems engineering	9.095					9.095	29.140	7.130	45.365
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			12.756	22.312		35.068	1078.360		1113.428
03.03.02.02	Nozzle			6.340	6.050		12.390	291.883		304.273
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.231	2.071		2.302	107.649		109.951
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.731	1.363		2.094	74.870		76.964
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.253	3.306		5.559	167.527		173.086
03.03.02.06	Thrust termination			.217	.766		.983	40.538		41.521
03.03.02.07	Structures			2.925	8.313		11.238	346.464		357.702
03.03.02.00	Subtotal SRM structures			25.453	44.181		69.634	2107.291		2176.925
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.934		2.934		2.934	2.934
03.05.00.00	System support			.734	1.980	7.382	10.096	281.133	108.022	399.251
03.06.00.00	Ground test	2.658	4.036	5.292			11.986			11.986
03.07.00.00	Flight operations				5.070		5.070		94.114	99.184
03.00.00.00	Total program	26.162	4.036	31.479	54.165	7.382	123.224	2471.531	209.266	2804.021

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION P4-120
PEAK LAUNCH RATE: 60/YR

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	14.409					14.409	55.387		69.796
03.02.00.00	Systems engineering	9.095					9.095	34.272	8.543	51.910
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			12.756	22.312		35.068	1332.169		1367.237
03.03.02.02	Nozzle			6.340	6.050		12.390	359.292		371.682
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.231	2.071		2.302	132.005		134.307
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.731	1.363		2.094	92.103		94.197
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.253	3.306		5.559	207.285		212.844
03.03.02.06	Thrust termination			.217	.766		.983	50.453		51.436
03.03.02.07	Structures			2.925	8.313		11.238	417.835		429.073
03.03.02.00	Subtotal SRM structures			25.453	44.181		69.634	2591.142		2660.776
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.934		2.934			2.934
03.05.00.00	System support			.734	1.980	7.382	10.096	350.570	118.931	479.597
03.06.00.00	Ground test	2.658	4.036	5.292			11.986			11.986
03.07.00.00	Flight operations				5.070		5.070		116.020	121.090
03.00.00.00	Total program	26.162	4.036	31.479	54.165	7.382	123.224	3031.371	243.494	3398.089

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1970 DOLLARS IN MILLIONS

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION P2-156
PEAK LAUNCH RATE: 10/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	12.440					12.440	28.778		41.218
03.02.00.00	Systems engineering	15.268					15.268	7.108	6.001	28.377
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			28.382	19.910		48.292	308.939		357.231
03.03.02.02	Nozzle			9.377	4.919		14.296	79.901		94.197
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.394	1.634		2.028	25.246		27.274
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.909	.735		1.644	12.359		14.003
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.409	1.624		4.033	26.470		30.503
03.03.02.06	Thrust termination			.181	.495		.676	8.253		8.929
03.03.02.07	Structures			3.151	8.061		11.212	120.560		131.772
03.03.02.00	Subtotal SRM structures			44.803	37.378		82.181	581.728		663.909
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.637		2.637			2.637
03.05.00.00	System support			.872	2.853	5.283	9.008	78.135	40.357	127.500
03.06.00.00	Ground test	8.464	29.021	9.011	3.400		46.496		21.420	46.496
03.07.00.00	Flight operations						3.400			24.820
03.00.00.00	Total program	36.172	29.021	54.686	46.268	5.283	171.430	695,749	67.778	934.957

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

CONFIGURATION P2-156
PEAK LAUNCH RATE: 20/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	12.440					12.440	28.585		41.025
03.02.00.00	Systems engineering	15.268					15.268	11.607	5.734	32.609
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			28.382	19.910		48.292	572.344		620.636
03.03.02.02	Nozzle			9.377	4.919		14.296	151.913		166.209
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.394	1.634		2.028	44.182		46.210
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.909	.735		1.644	23.424		25.068
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.409	1.624		4.033	50.047		54.080
03.03.02.06	Thrust termination			.181	.495		.676	15.576		16.252
03.03.02.07	Structures			3.151	8.061		11.212	205.596		216.808
03.03.02.00	Subtotal SRM structures			44.803	37.378		82.181	1063.082		1145.263
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.637		2.637		2.637	2.637
03.05.00.00	System support			.872	2.853	5.283	9.008	124.317	72.935	206.260
03.06.00.00	Ground test	8.464	29.021	9.011			46.496			46.496
03.07.00.00	Flight operations				3.400		3.400		31.299	34.699
03.00.00.00	Total program	36.172	29.021	54.686	46.268	5.283	171.430	1227.591	109.968	1508.989

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

CONFIGURATION P2-156
PEAK LAUNCH RATE: 40/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	12.440					12.440	29.555		41.995
03.02.00.00	Systems engineering	15.268					15.268	18.870	6.264	40.402
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			28.382	19.910		48.292	1003.116		1051.408
03.03.02.01	Motor case and propellant			9.377	4.919		14.296	267.972		282.268
03.03.02.02	Nozzle									
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.394	1.634		2.028	75.450		77.478
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.909	.735		1.644	41.270		42.914
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.409	1.624		4.033	87.608		91.641
03.03.02.06	Thrust termination			.181	.495		.676	27.210		27.886
03.03.02.07	Structures			3.151	8.061		11.212	336.371		347.583
03.03.02.00	Subtotal SRM structures			44.803	37.378		82.181	1838.997		1921.178
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.637		2.637		2.637	2.637
03.05.00.00	System support			.872	2.853	5.283	9.008	207.351	102.630	318.989
03.06.00.00	Ground test	8.464	29.021	9.011	3.400		46.496		52.006	46.496
03.07.00.00	Flight operations						3.400			55.406
03.00.00.00	Total program	36.172	29.021	54.686	46.268	5.283	171.430	2094.773	160.900	2427.103

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FOLDOUT FRAME

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

CONFIGURATION P2-156

PEAK LAUNCH RATE: 60/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	12.440					12.440	30.058		42.498
03.02.00.00	Systems engineering	15.268					15.268	23.083	6.610	44.961
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			28.382	19.910		48.292	1237.790		1286.082
03.03.02.02	Nozzle			9.377	4.919		14.296	331.379		345.675
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)									
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.394	1.634		2.028	91.673		93.701
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			.909	.735		1.644	50.804		52.448
03.03.02.06	Thrust termination			2.409	1.624		4.033	107.242		111.275
03.03.02.07	Structures			.181	.495		.676	33.315		33.991
				3.151	8.061		11.212	400.379		411.591
03.03.02.00	Subtotal SRM structures			44.803	37.378		82.181	2252.582		2334.763
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.637		2.637			2.637
03.05.00.00	System support			.872	2.853	5.283	9.008	254.419	109.463	372.890
03.06.00.00	Ground test	8.464	29.021	9.011			46.496			46.496
03.07.00.00	Flight operations				3.400		3.400		62.662	66.062
03.00.00.00	Total program	36.172	29.021	54.686	46.268	5.283	171.430	2560.142	178.735	2910.307

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1970 DOLLARS IN MILLIONS

CONFIGURATION S6-120
PEAK LAUNCH RATE: 10/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year													
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Nonrecurring Total	2.474	16.358	26.617	29.252	45.564	43.995	4.843							
DESIGN, DEVELOPMENT, TEST, AND EVALUATION														
DEVELOPMENT														
DEVELOPMENT	2.170	4.695	5.038	5.314	3.861	4.614	2.537							
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123									
DELIVERABLE HARDWARE														
DUMMY SRM		10.092	14.407	15.758	1.965									
FLIGHT SRM	.145	.392	5.026	7.240	31.954	29.980	.516							
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.115	.146	.205	7.661	9.401	1.790							
RECURRING TOTAL						58.181	126.506	131.700	124.726	123.495	123.495	123.495	123.495	123.495
INVESTMENT (PRODUCTION)						56.592	119.865	121.043	114.364	113.183	113.183	113.185	113.185	113.185
DELIVER NEW SRM														
GROUND SUPPORT EQUIPMENT														
PRODUCTION - SPARES														
OPERATIONS						1.589	6.641	10.657	10.362	10.310	10.310	10.310	10.310	10.310
FLIGHT SUPPORT														
OPERATIONS														
SPARES														
FACILITIES														
TOTAL PROGRAM	2.474	16.358	26.617	29.252	45.564	102.176	131.349	131.700	124.726	123.495	123.495	123.495	123.495	123.495

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1970 DOLLARS IN MILLIONS

CONFIGURATION S6-120
PEAK LAUNCH RATE: 20/YR.

TABLE 2															
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS															
Cost Element	Fiscal Year														
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Nonrecurring Total	2.474	16.358	26.617	29.252	45.564	43.995	4.843								
DESIGN, DEVELOPMENT, TEST, AND EVALUATION															
DEVELOPMENT															
DEVELOPMENT	2.170	4.695	5.038	5.314	3.861	4.614	2.537								
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123										
DELIVERABLE HARDWARE															
DUMMY SRM		10.092	14.407	15.758	1.965										
FLIGHT SRM	.145	.392	5.026	7.240	31.954	29.980	.516								
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 3)	.045	.115	.146		7.661	9.401	1.790								
RECURRING TOTAL						94.893	216.110	243.765	338.738	232.577	231.978	231.978	231.978	231.978	231.978
INVESTMENT (PRODUCTION)						93.304	205.987	224.131	217.506	212.077	212.077	212.077	212.077	212.077	212.077
DELIVER NEW SRM															
GROUND SUPPORT EQUIPMENT															
PRODUCTION - SPARES															
OPERATIONS						1.589	10.123	19.614	21.232	20.500	19.901	19.901	19.901	19.901	19.901
FLIGHT SUPPORT															
OPERATIONS															
SPARES															
FACILITIES															
TOTAL PROGRAM	2.474	16.358	26.617	29.252	45.564	138.888	220.953	243.765	238.738	232.577	231.978	231.978	231.978	231.978	231.978

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1970 DOLLARS IN MILLIONS

CONFIGURATION S6-120
PEAK LAUNCH RATE: 40/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	2.474	16.358	26.617	29.252	45.564	43.995	4.843											169.103
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	2.170	4.695	5.038	5.314	3.861	4.614	2.537											28.229
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123													4.036
DELIVERABLE HARDWARE																		
DUMMY SRM		10.092	14.407	15.758	1.465													42.222
FLIGHT SRM	.145	.392	5.026	7.240	31.954	29.980	.516											75.253
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.115	.146	.205	7.661	9.401	1.790											19.363
RECURRING TOTAL						94.973	238.949	332.737	412.014	446.324	439.219	432.487	431.878	431.878	431.878	231.061	15.127	3938.525
INVESTMENT (PRODUCTION)																		
DELIVER NEW SRM						93.384	228.983	312.114	385.724	415.882	407.488	401.631	401.631	401.631	401.631	200.812		3650.911
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.589	9.966	20.623	26.290	30.442	31.731	30.856	30.247	30.247	30.247	30.249	15.127	287.614
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	2.474	16.358	26.617	29.252	45.564	138.968	243.792	332.737	412.014	446.324	439.219	432.487	431.878	431.878	431.878	231.061	15.127	4107.628

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1970 DOLLARS IN MILLIONS

CONFIGURATION S6-120
PEAK LAUNCH RATE: 60/YR.

TABLE 2																		
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS																		
Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	2.474	16.358	26.617	29.252	45.564	43.995	4.843											169.103
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	2.170	4.695	5.038	5.314	3.861	4.614	2.537											28.229
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123													4.036
DELIVERABLE HARDWARE																		
DUMMY SRM		10.092	14.407	15.758	1.965													42.222
FLIGHT SRM	.145	.392	5.026	7.240	31.954	29.980	.516											75.253
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.115	.146	.205	7.661	9.401	1.790											19.363
RECURRING TOTAL								334.241	420.438	503.108	583.724	628.973	632.022	628.805	527.524	228.261	14.753	4837.885
INVESTMENT (PRODUCTION)								313.514	394.037	471.983	548.411	589.438	590.241	587.164	486.203	192.879		4498.281
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.589	10.036	20.727	26.401	31.125	35.313	39.535	41.781	41.641	41.321	35.382	14.753	339.604
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	2.474	16.358	26.617	29.252	45.564	139.748	245.126	334.241	420.438	503.108	583.724	628.973	632.022	628.805	527.524	228.261	14.753	5006.988

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TABLE 2															
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS															
Cost Element	Fiscal Year														
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Total
Nonrecurring Total	9.662	29.635	45.951	44.115	41.491	35.984	3.354								210.192
DESIGN, DEVELOPMENT, TEST, AND EVALUATION															
DEVELOPMENT															
DEVELOPMENT	3.873	8.928	8.138	7.010	4.747	3.799	1.482								37.977
SPECIAL TEST EQUIPMENT AND TOOLING	3.372	7.987	10.821	6.636	.205										29.021
DELIVERABLE HARDWARE															
DUMMY SRM	2.218	11.831	25.936	20.619	3.605										64.209
FLIGHT SRM	.154	.773	.910	9.646	27.453	25.348	.453								64.737
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.116	.146	.204	5.481	6.837	1.419								14.248
RECURRING TOTAL						80.272	182.047	204.112	201.562	199.131	199.029	199.029	199.029	199.029	1977.819
INVESTMENT (PRODUCTION)															
DELIVER NEW SRM															
GROUND SUPPORT EQUIPMENT															
PRODUCTION - SPARES															
OPERATIONS						1.573	7.718	14.747	16.332	16.142	16.040	16.040	16.040	16.040	160.770
FLIGHT SUPPORT															
OPERATIONS															
SPARES															
FACILITIES															
TOTAL PROGRAM	9.662	29.635	45.951	44.115	41.491	116.256	185.401	204.112	201.562	199.131	199.029	199.029	199.029	199.029	2188.011

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1970 DOLLARS IN MILLIONS

CONFIGURATION S3-156
PEAK LAUNCH RATE: 60/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	9.662	29.635	45.951	44.115	41.491	35.984	3.354											210.192
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	3.873	8.928	8.138	7.010	4.747	3.799	1.482											37.977
SPECIAL TEST EQUIPMENT AND TOOLING	3.372	7.987	10.821	6.636	.205													29.021
DELIVERABLE HARDWARE																		
DUMMY SRM	2.218	11.831	25.936	20.619	3.605													64.209
FLIGHT SRM	.154	.773	.910	9.646	27.453	25.348	.453											64.737
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.116	.146	.204	5.481	6.837	1.419											14.248
RECURRING TOTAL						81.906	203.961	278.004	348.671	422.580	493.267	531.175	532.874	530.808	446.404	191.943	10.845	4072.438
INVESTMENT (PRODUCTION)						80.333	195.740	261.879	329.228	400.443	468.146	503.159	503.484	501.567	417.357	166.574		3827.910
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.573	8.221	16.125	19.443	22.137	25.121	28.016	29.390	29.241	29.047	25.369	10.845	244.528
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	9.662	29.635	45.951	44.115	41.491	117.890	207.315	278.004	348.671	422.580	493.267	531.175	532.874	530.808	446.404	191.943	10.845	4282.630

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1970 DOLLARS IN MILLIONS

CONFIGURATION P4-120
PEAK LAUNCH RATE: 10/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME--PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	2.346	7.221	25.212	24.122	31.266	29.245	3.812											123.224
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	2.041	4.424	4.736	5.006	3.594	4.139	2.222											26.162
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123													4.036
DELIVERABLE HARDWARE																		
DUMMY SRM		1.226	14.762	13.401	2.090													31.479
FLIGHT SRM	.145	.392	3.568	4.776	20.702	19.170	.342											49.095
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.046	.115	.146	.204	4.757	5.936	1.248											12.452
RECURRING TOTAL						48.113	93.854	90.273	88.415	88.296	88.296	88.296	88.296	88.295	88.295	47.904	3.758	902.091
INVESTMENT (PRODUCTION)						47.053	88.101	81.436	80.777	80.777	80.777	80.777	80.777	80.777	80.777	40.387		822.416
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.060	5.753	8.837	7.638	7.519	7.519	7.519	7.519	7.518	7.518	7.517	3.758	79.675
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	2.346	7.221	25.212	24.122	31.266	77.358	97.666	90.273	88.415	88.296	88.296	88.296	88.296	88.295	88.295	47.904	3.758	1025.315

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1970 DOLLARS IN MILLIONS

CONFIGURATION P4-120
PEAK LAUNCH RATE; 20/YR.

TABLE 2																		
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS																		
Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	2.346	7.221	25.212	24.122	31.266	29.245	3.812											123.224
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	2.041	4.424	4.736	5.006	3.594	4.139	2.222											26.126
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123													4.036
DELIVERABLE HARDWARE																		
DUMMY SRM		1.226	14.762	13.401	2.090													31.479
FLIGHT SRM	.145	.392	3.568	4.776	20.702	19.170	.342											49.095
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.046	.115	.146	.204	4.757	5.936	1.248											12.452
RECURRING TOTAL						63.933	146.700	168.757	168.228	164.560	164.109	164.109	164.109	164.109	164.111	89.009	6.955	1628.689
INVESTMENT (PRODUCTION)						62.873	139.717	155.389	153.649	150.208	150.208	150.208	150.208	150.208	150.208	75.106		1487.982
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.060	6.983	13.368	14.579	14.352	13.901	13.901	13.901	13.901	13.903	13.903	6.955	140.707
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	2.346	7.221	25.212	24.122	31.266	93.178	150.512	168.757	168.228	164.560	164.109	164.109	164.109	164.109	164.111	89.009	6.955	1751.913

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1970 DOLLARS IN MILLIONS

CONFIGURATION P4-120
PEAK LAUNCH RATE: 40/YR.

TABLE 2															
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS															
Cost Element	Fiscal Year														
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Total
Nonrecurring Total	2.346	7.221	25.212	24.122	31.266	29.245	3.812								123.224
DESIGN, DEVELOPMENT, TEST, AND EVALUATION															
DEVELOPMENT															
DEVELOPMENT	2.041	4.424	4.736	5.006	3.594	4.139	2.222								26.162
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123										4.036
DELIVERABLE HARDWARE															
DUMMY SRM		1.226	14.762	13.401	2.090										31.479
FLIGHT SRM	.145	.392	3.568	4.776	20.702	19.170	.342								49.095
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.046	.115	.146	.204	4.757	5.936	1.248								12.452
RECURRING TOTAL						64.020	158.116	221.238	279.330	305.511	301.190	295.746	295.253	293.253	2680.797
INVESTMENT (PRODUCTION)						62.960	151.356	206.966	260.569	283.370	277.875	272.986	272.986	272.986	2471.531
DELIVER NEW SRM															
GROUND SUPPORT EQUIPMENT															
PRODUCTION - SPARES															
OPERATIONS						1.060	6.760	14.272	18.761	22.141	23.315	22.760	22.267	22.267	209.266
FLIGHT SUPPORT															
OPERATIONS															
SPARES															
FACILITIES															
TOTAL PROGRAM	2.346	7.221	25.212	24.122	31.266	93.265	161.928	221.238	279.330	305.511	301.190	295.746	295.253	295.253	2804.021

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1970 DOLLARS IN MILLIONS

CONFIGURATION P4-120
PEAK LAUNCH RATE: 60/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	2.346	7.221	25.212	24.122	31.266	29.245	3.812											123.224
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	2.041	4.424	4.736	5.006	3.594	4.139	2.222											26.162
SPECIAL TEST EQUIPMENT AND TOOLING	.114	1.064	2.000	.735	.123													4.036
DELIVERABLE HARDWARE																		
DUMMY SRM		1.226	14.762	13.401	2.090													31.479
FLIGHT SRM	.145	.392	3.568	4.776	20.702	19.170	.342											49.095
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.046	.115	.146	.204	4.757	5.936	1.248											12.452
RECURRING TOTAL						64.443	158.954	222.056	282.997	243.333	401.669	429.413	426.613	422.016	356.244	156.302	10.825	3274.865
INVESTMENT (PRODUCTION)						63.383	151.979	207.507	263.999	320.704	375.979	400.562	396.476	392.547	327.254	130.981		3031.371
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.060	6.975	14.549	18.998	22.629	25.690	28.851	30.137	29.469	28.990	25.321	10.825	243.494
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	2.346	7.221	25.212	24.122	31.266	93.688	162.766	222.056	282.997	243.333	401.669	429.413	426.613	422.016	356.244	156.302	10.825	3398.089

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1970 DOLLARS IN MILLIONS

CONFIGURATION P2-156
PEAK LAUNCH RATE: 10/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	9.517	27.724	43.616	32.207	31.896	24.050	2.420											171.430
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	3.728	8.642	7.836	6.700	4.477	3.480	1.309											36.172
SPECIAL TEST EQUIPMENT AND TOOLING	3.372	7.987	10.821	6.636	.205													29.021
DELIVERABLE HARDWARE																		
DUMMY SRM	2.218	10.207	23.903	15.025	3.333													54.686
FLIGHT SRM	.154	.772	.910	3.642	20.531	16.527	.332											42.868
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.116	.146	.204	3.350	4.043	.779											8.683
RECURRING TOTAL						39.973	78.750	76.060	74.981	74.981	74.981	74.980	74.980	74.979	74.979	40.686	3.197	763.527
INVESTMENT (PRODUCTION)						38.924	73.812	68.590	68.590	68.590	68.590	68.590	68.590	68.589	68.589	34.295		695.749
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.049	4.938	7.470	6.391	6.391	6.391	6.390	6.390	6.390	6.390	6.391	3.197	67.778
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	9.517	27.724	43.616	32.207	31.896	64.023	81.170	76.060	74.981	74.981	74.981	74.980	74.980	74.979	74.979	40.686	3.197	934.957

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1970 DOLLARS IN MILLIONS

CONFIGURATION P2-156
PEAK LAUNCH RATE: 20/YR.

TABLE 2																		
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS																		
Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	9.517	27.724	43.616	32.207	31.896	24.050	2.420											171.430
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT	3.728	8.642	7.836	6.700	4.477	3.480	1.309											36.172
DEVELOPMENT	3.372	7.987	10.821	6.636	.205													29.021
SPECIAL TEST EQUIPMENT AND TOOLING																		
DELIVERABLE HARDWARE																		
DUMMY SRM	2.218	10.207	23.903	15.025	3.333													54.686
FLIGHT SRM	.154	.772	.910	3.642	20.531	16.527	.332											42.868
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.116	.146	.204	3.350	4.043	.779											8.683
RECURRING TOTAL						52.144	119.758	137.386	137.479	135.637	135.334	135.334	135.334	135.336	135.336	73.081	5.400	1337.559
INVESTMENT (PRODUCTION)						51.096	114.070	126.941	126.218	124.503	124.503	124.503	124.503	124.503	124.503	62.248		1227.591
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.048	5.688	10.445	11.261	11.134	10.831	10.831	10.831	10.833	10.833	10.833	5.400	109.968
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	9.517	27.724	43.616	32.207	31.896	76.194	122.178	137.386	137.479	135.637	135.334	135.334	135.334	135.336	135.336	73.081	5.400	1508.989

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1970 DOLLARS IN MILLIONS

CONFIGURATION P2-156
PEAK LAUNCH RATE: 40/YR.

TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	9.517	27.724	43.616	32.207	31.896	24.050	2.420											171.430
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	3.728	8.642	7.836	6.700	4.477	3.480	1.309											36.172
SPECIAL TEST EQUIPMENT AND TOOLING	3.372	7.987	10.821	6.636	.205													29.021
DELIVERABLE HARDWARE																		
DUMMY SRM	2.218	10.207	23.903	15.025	3.333													54.686
FLIGHT SRM	.154	.772	.910	3.642	20.531	16.527	.332											42.868
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.116	.146	.204	3.350	4.043	.779											8.683
RECURRING TOTAL						54.505	134.403	186.071	233.232	254.132	252.048	250.088	249.832	249.832	249.830	133.308	8.392	2255.673
INVESTMENT (PRODUCTION)						53.457	128.380	174.277	218.346	237.005	234.610	233.044	233.044	233.044	233.044	116.522		2094.773
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS						1.048	6.023	11.794	14.886	17.127	17.438	17.044	16.788	16.788	16.786	16.786	8.392	160.900
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	9.517	27.724	43.616	32.207	31.896	78.555	136.823	186.071	233.232	254.132	252.048	250.088	249.832	249.832	249.830	133.308	8.392	2427.103

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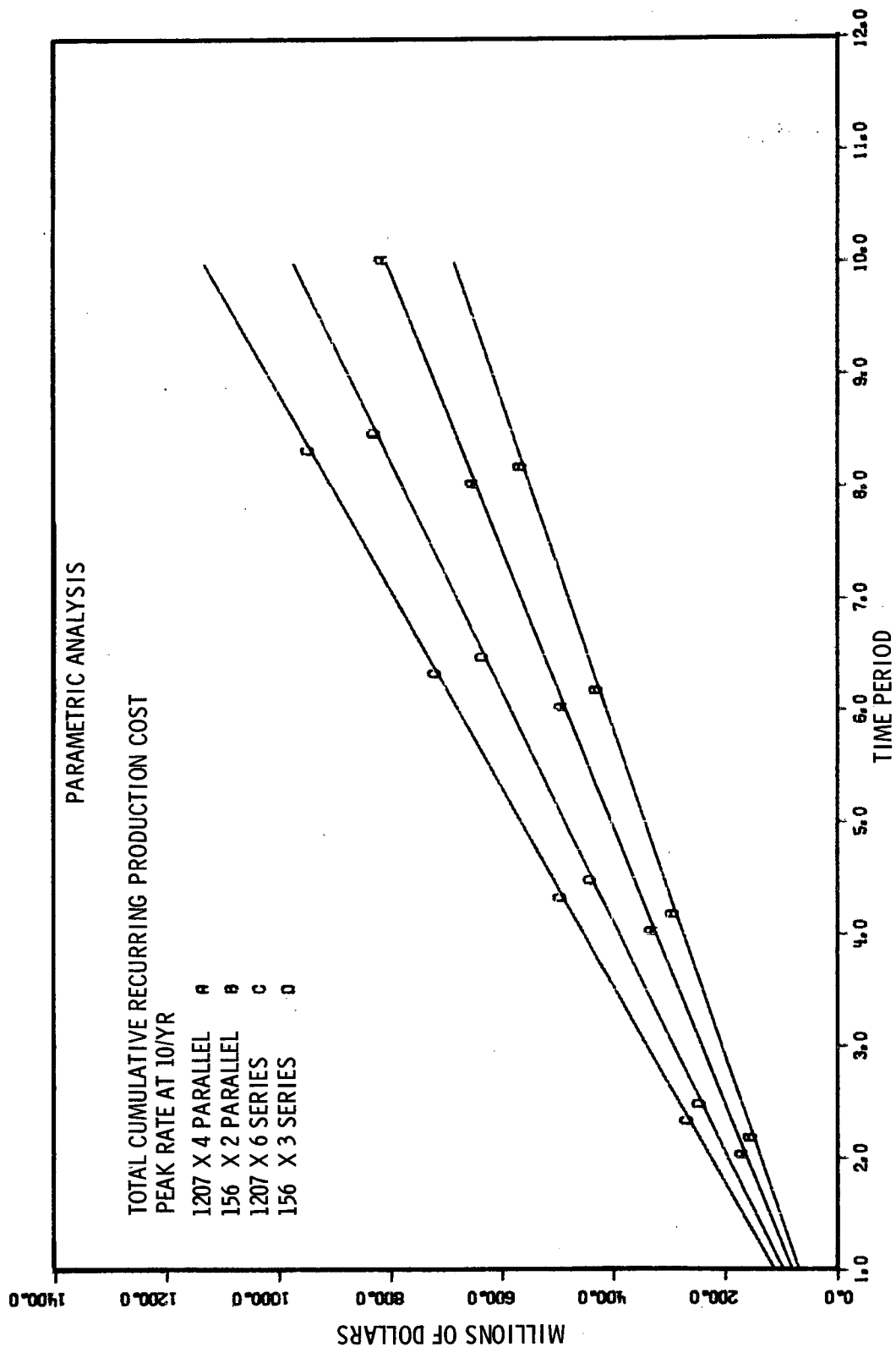
1970 DOLLARS IN MILLIONS

CONFIGURATION P2-156
PEAK LAUNCH RATE: 60/YR.

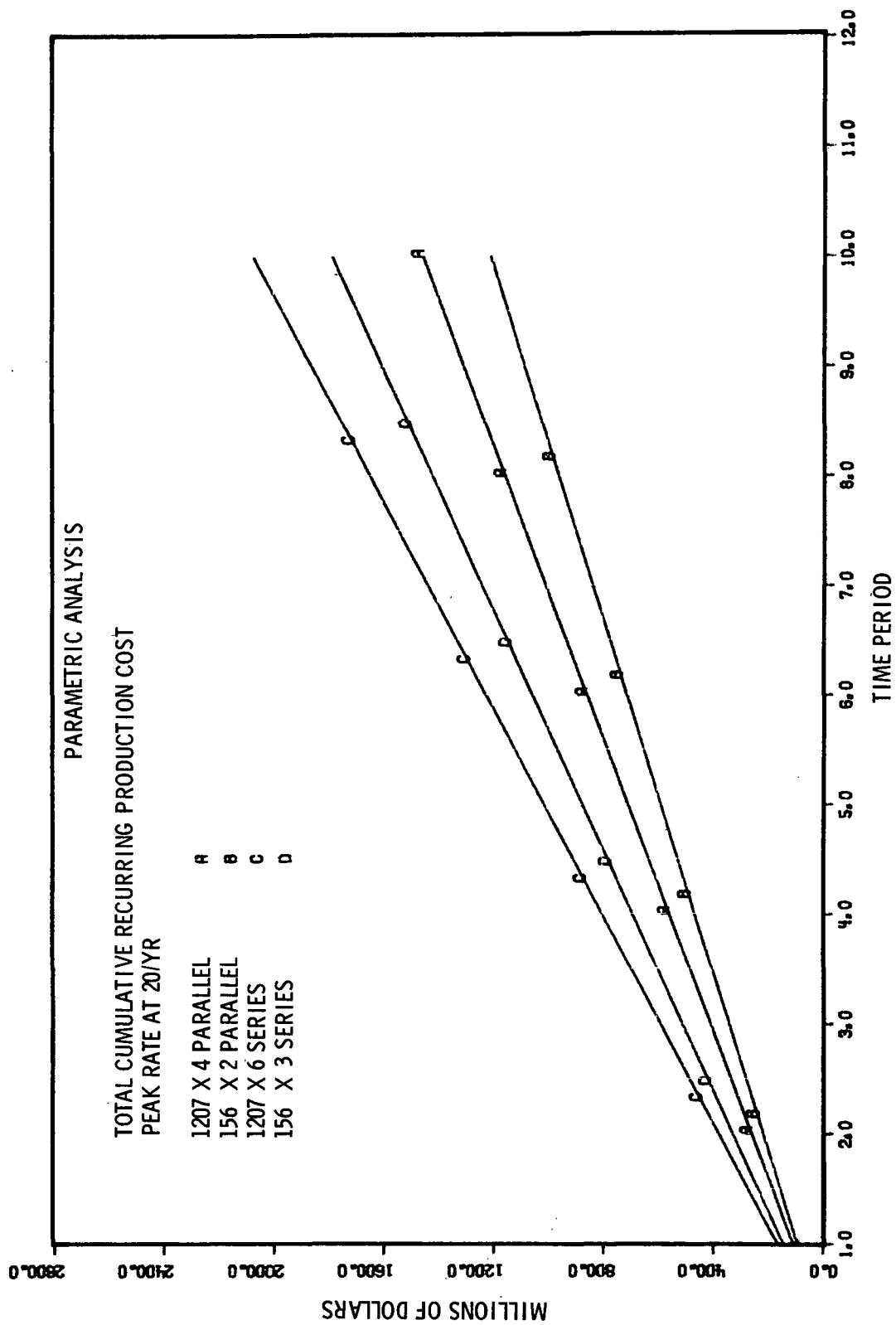
TABLE 2
SRM BOOSTER STAGE PROGRAM TIME-PHASED FUNDING REQUIREMENTS

Cost Element	Fiscal Year																	
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Nonrecurring Total	9.517	27.724	43.616	32.207	31.896	24.050	2.420											171.430
DESIGN, DEVELOPMENT, TEST, AND EVALUATION																		
DEVELOPMENT																		
DEVELOPMENT	3.728	8.642	7.836	6.700	4.477	3.480	1.309											36.172
SPECIAL TEST EQUIPMENT AND TOOLING	3.372	7.987	10.821	6.636	.205													29.021
DELIVERABLE HARDWARE																		
DUMMY SRM	2.218	10.207	23.903	15.025	3.333													54.686
FLIGHT SRM	.154	.772	.910	3.642	20.531	16.527	.332											42.868
OPERATIONS AND FLIGHT SUPPORT AND SPARES (1, 2, AND 5)	.045	.116	.146	.204	3.350	4.043	.779											8.683
RECURRING TOTAL								186.365	236.036	283.610	332.899	358.765	357.741	355.840	299.815	130.188	8.194	2738.877
INVESTMENT (PRODUCTION)								174.733	221.256	266.519	314.350	338.298	336.490	335.064	279.235	111.704		2560.142
DELIVER NEW SRM																		
GROUND SUPPORT EQUIPMENT																		
PRODUCTION - SPARES																		
OPERATIONS																		
OPERATIONS																		
FLIGHT SUPPORT																		
FLIGHT SUPPORT																		
OPERATIONS																		
SPARES																		
SPARES																		
FACILITIES																		
TOTAL PROGRAM	9.517	27.724	43.616	32.207	31.896	78.853	137.041	186.365	236.036	283.610	332.899	358.765	357.741	355.840	299.815	130.188	8.194	2910.307

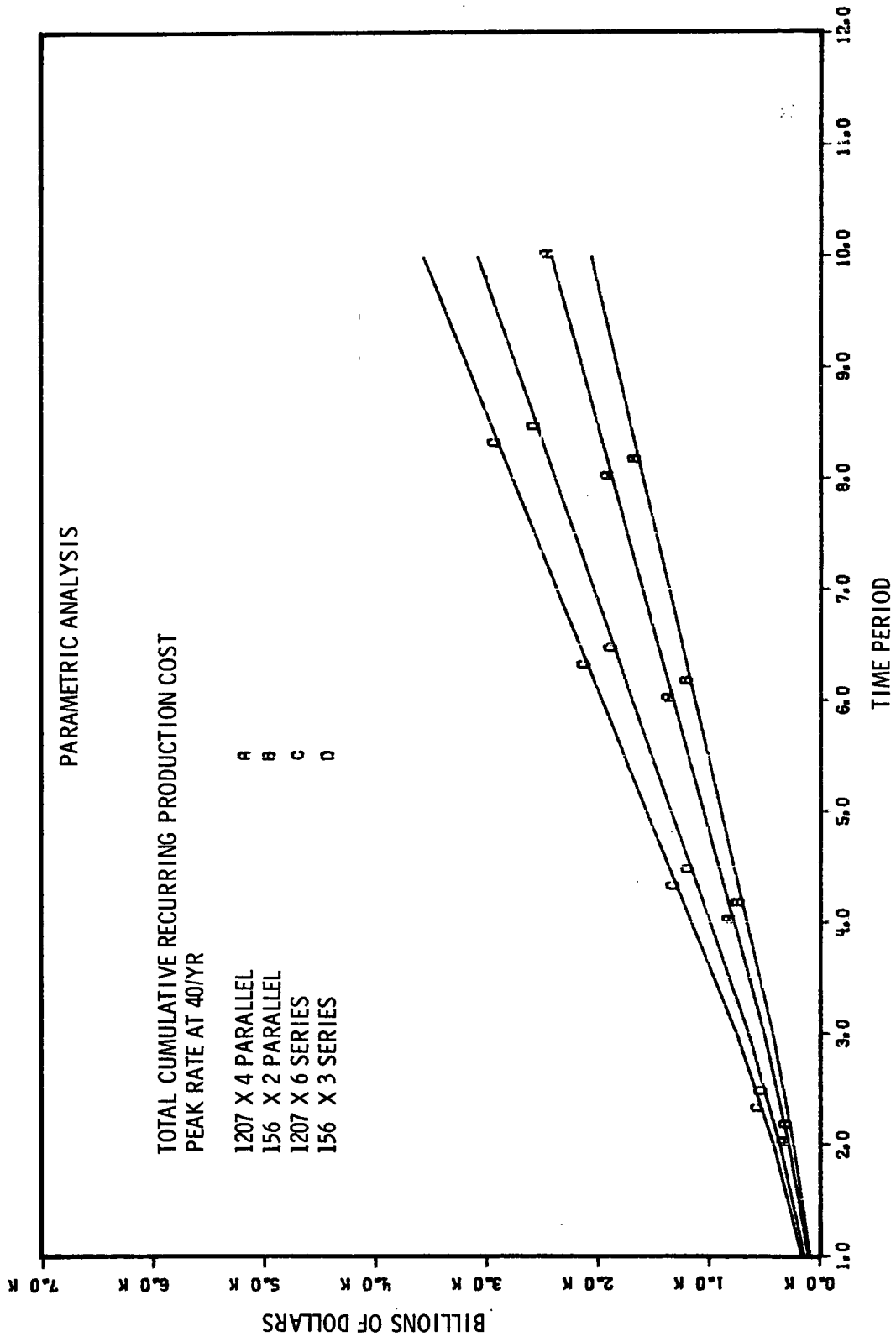
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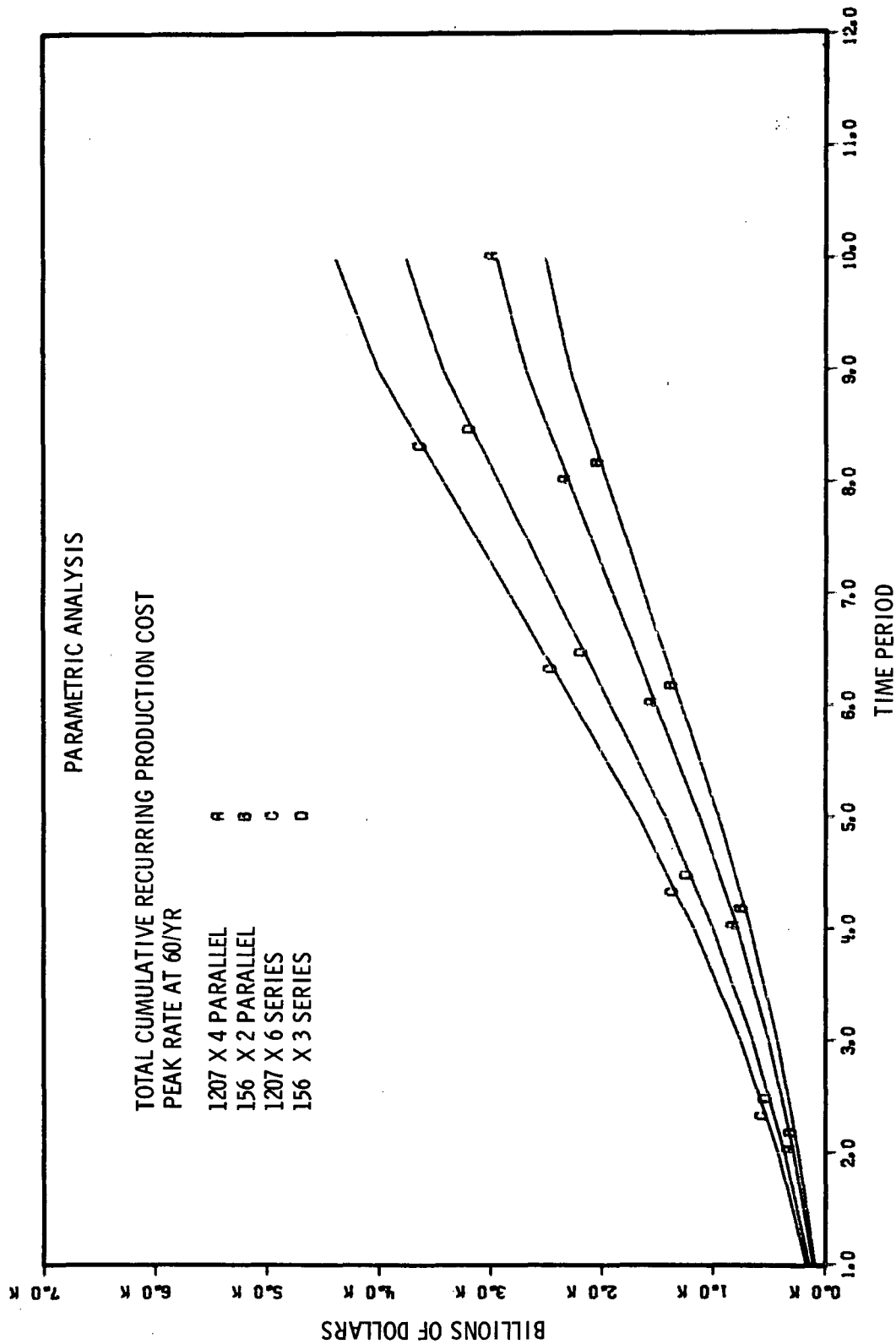
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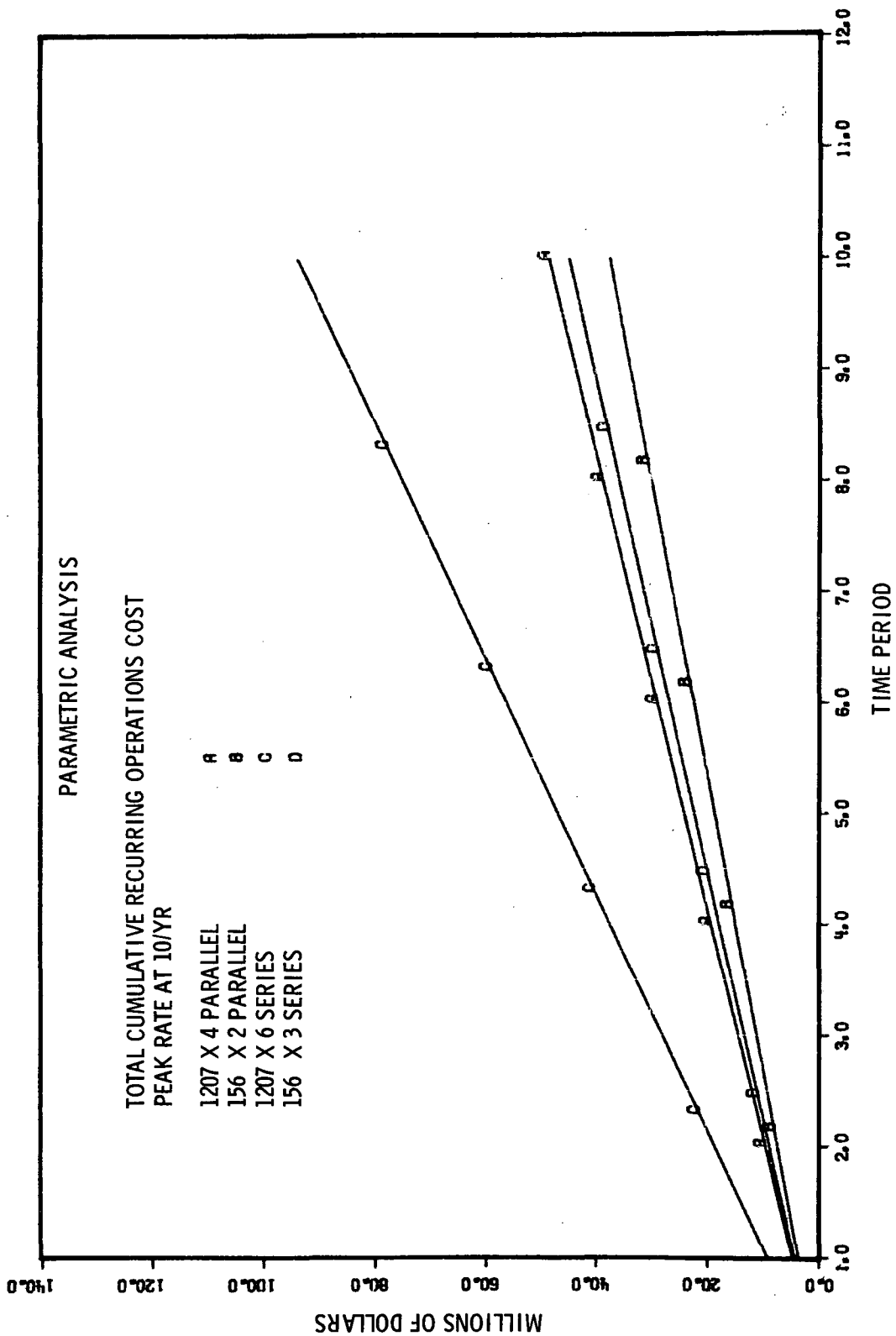
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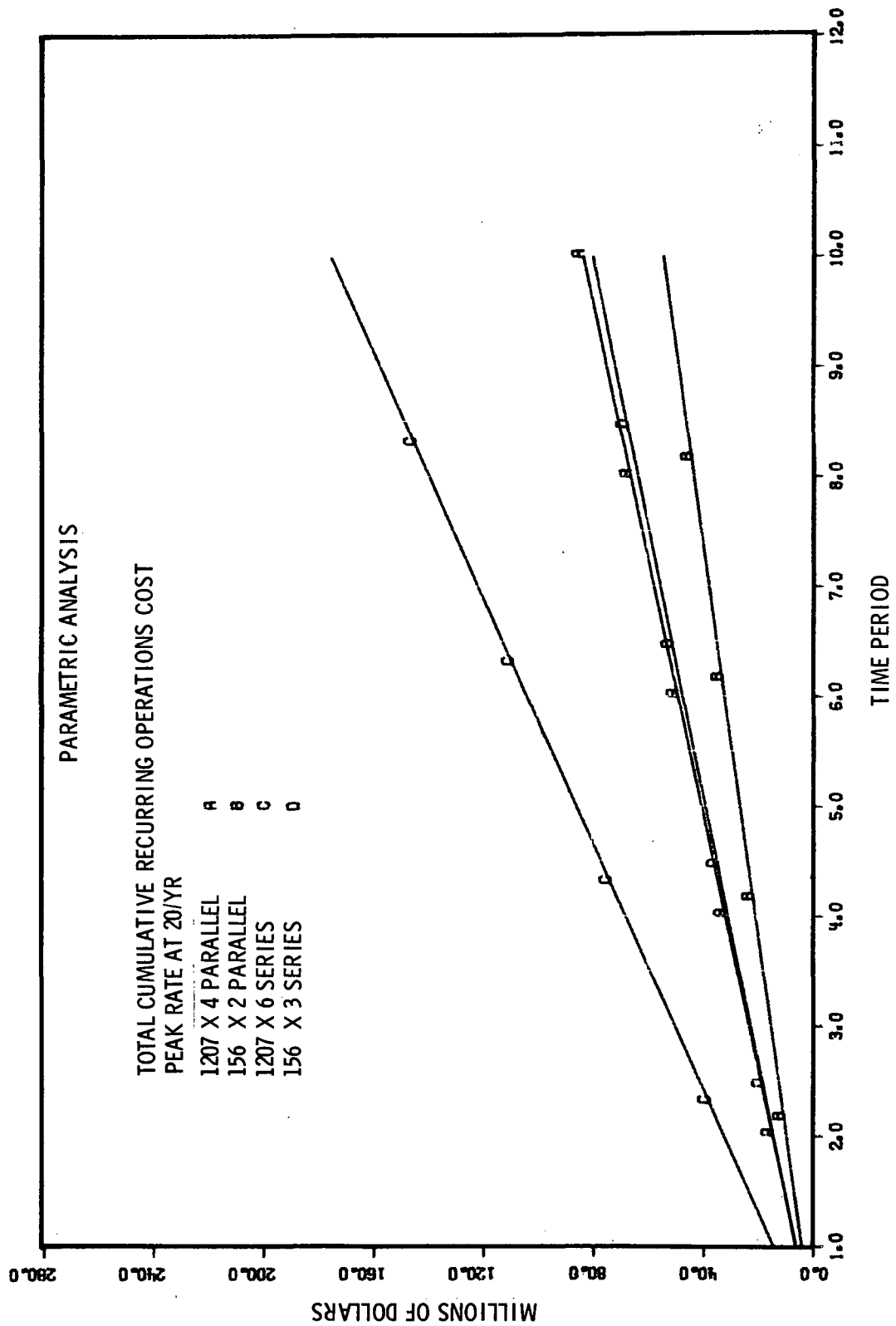
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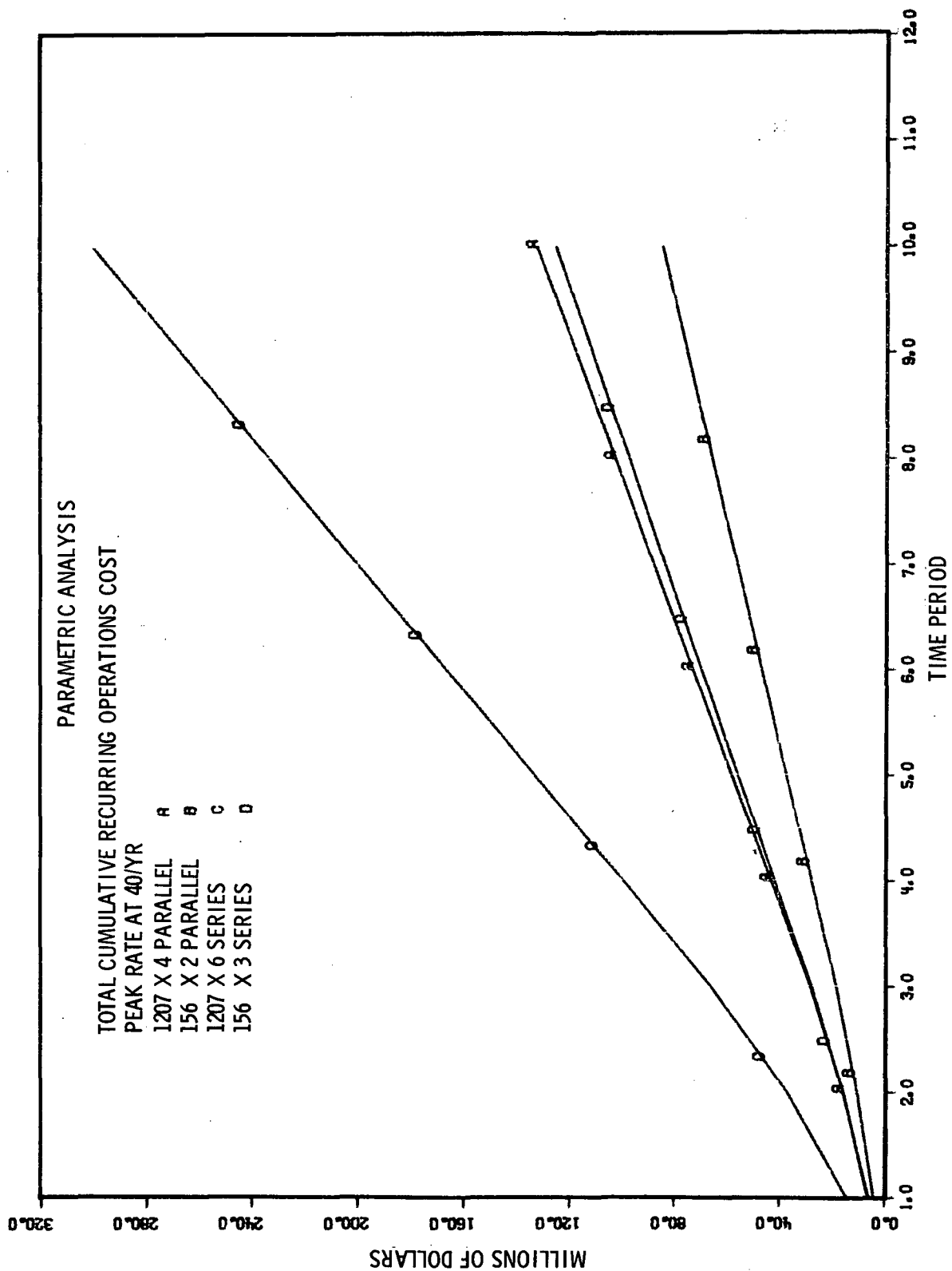
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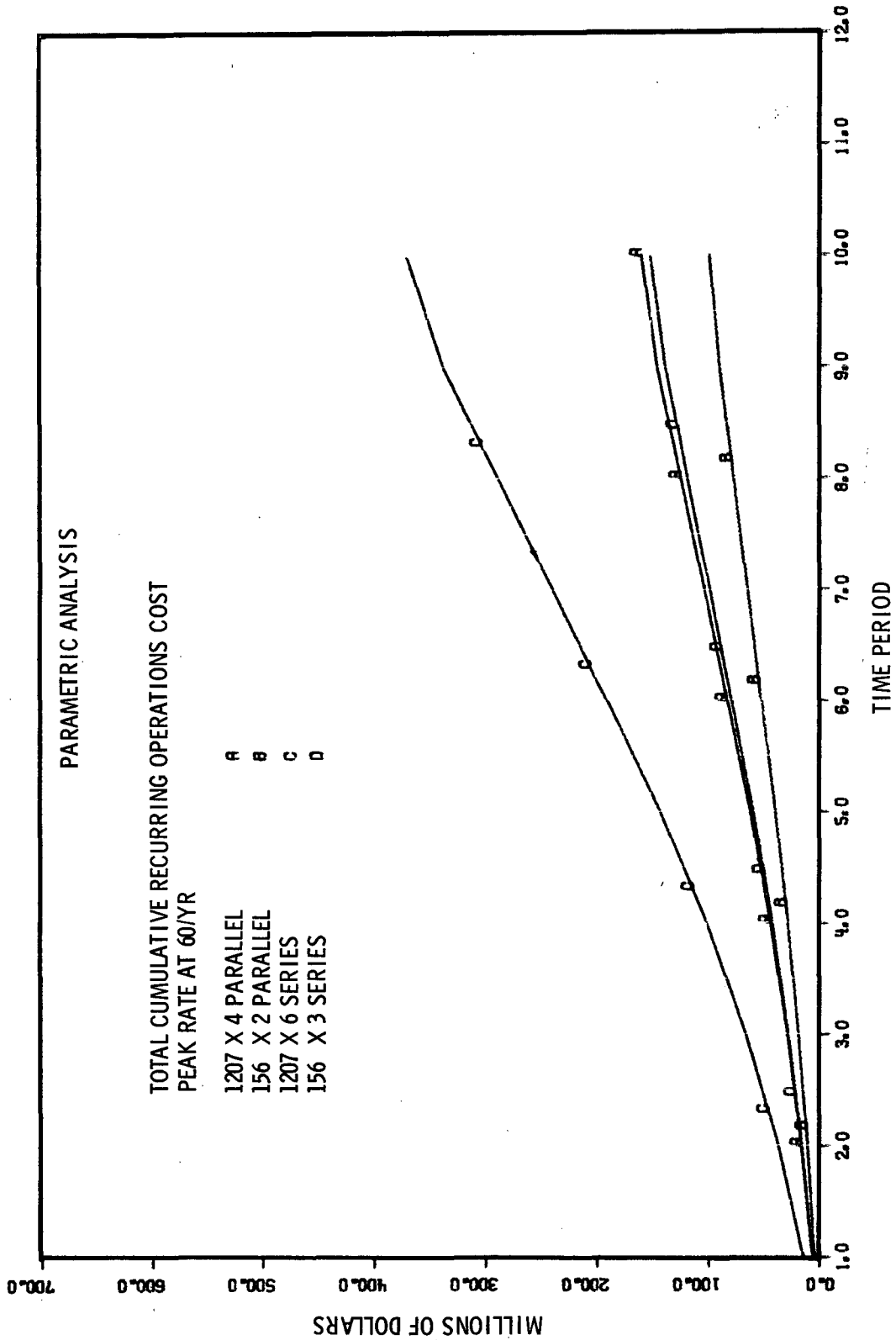
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FOLDOUT FRAME

FOLDOUT FRAME

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

SMALL ORBITER
CONFIGURATION P3-120
PEAK LAUNCH RATE: 20/YR.

1970 DOLLARS IN MILLIONS

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	14.409					14.409	39.776		54.185
03.02.00.00	Systems engineering	9.095					9.095	13.547	4.868	27.510
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			11.255	16.734		27.989	467.447		495.436
03.03.02.02	Nozzle			5.594	4.538		10.132	125.222		135.354
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.204	1.553		1.757	47.829		49.586
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.645	1.022		1.667	32.372		34.039
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			1.988	2.480		4.468	72.983		77.451
03.03.02.06	Thrust termination			.191	5.745		5.936	17.666		23.602
03.03.02.07	Structures			2.581			2.581			2.581
03.03.02.00	Subtotal SRM structures			22.458	32.072		54.530	763.519		818.049
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.934		2.934		2.934	2.934
03.05.00.00	System support			.734	1.980		2.714	133.841	58.088	194.643
03.06.00.00	Ground test	2.658	4.036	5.292		7.382	19.368			19.368
03.07.00.00	Flight operations				5.070		5.070		42.575	47.645
03.00.00.00	Total program	26.162	4.036	28.484	42.056	7.382	108.120	950.683	105.531	1164.334

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FOLDOUT FRAME

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

SMALL ORBITER
CONFIGURATION P3-120
PEAK LAUNCH RATE: 60/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	14.409					14.409	41.540		55.949
03.02.00.00	Systems engineering	9.095					9.095	25.704	6.512	41.311
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure									
03.03.02.01	Motor case and propellant			11.255	16.734		27.989	999.127		1027.116
03.03.02.02	Nozzle			5.594	4.538		10.132	269.469		279.601
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.204	1.553		1.757	99.004		100.761
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.645	1.022		1.667	69.077		70.744
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			1.988	2.480		4.468	155.464		159.932
03.03.02.06	Thrust termination			.191	5.745		5.936	37.840		43.776
03.03.02.07	Structures			2.581			2.581	313.376		315.957
03.03.02.00	Subtotal SRM structures			22.458	32.072		54.530	1943.357		1997.887
03.03.00.00	Subtotal SRM aerospace vehicle equipment									
03.04.00.00	Facilities (activation)				2.934		2.934			2.934
03.05.00.00	System support			.734	1.980		2.714	262.927	89.198	354.839
03.06.00.00	Ground test	2.658	4.036	5.292		7.382	19.368			19.368
03.07.00.00	Flight operations				5.070		5.070		87.015	92.085
03.00.00.00	Total program	26.162	4.036	28.484	42.056	7.382	108.120	2273.528	182.725	2564.373

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TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

SMALL ORBITER
CONFIGURATION S2-156
PEAK LAUNCH RATE: 20/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	13.801					13.801	28.585		42.386
03.02.00.00	Systems engineering	15.712					15.712	11.607	5.734	33.053
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.535	2.188		2.723	114.758		117.481
03.03.02.01	Motor case and propellant			30.448	20.966		51.414	572.344		623.758
03.03.02.02	Nozzle			9.377	5.167		14.544	151.913		166.457
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.394	1.634		2.028	44.182		46.210
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.909	.782		1.691	23.424		25.115
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.473	1.712		4.185	50.047		54.232
03.03.02.06	Thrust termination			.212	.518		.730	15.576		16.306
03.03.02.07	Structures			4.254	8.282		12.536	205.596		218.132
03.03.02.00	Subtotal SRM structures			48.067	39.061		87.128	1063.082		1150.210
03.03.00.00	Subtotal SRM aerospace vehicle equipment			48.602	41.249		89.851	1177.840		1267.691
03.04.00.00	Facilities (activation)				2.637		2.637			2.637
03.05.00.00	System support			.872	3.024	7.311	11.207	124.317	72.935	208.459
03.06.00.00	Ground test	8.464	29.021	9.319			46.804			46.804
03.07.00.00	Flight operations				3.604		3.604		31.299	34.903
03.00.00.00	Total program	37.977	29.021	58.793	50.514	7.311	183.616	1342.349	109.968	1635.933

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

1970 DOLLARS IN MILLIONS

SMALL ORBITER
CONFIGURATION S2-156
PEAK LAUNCH RATE: 60/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	13.801					13.801	30.058		43.859
03.02.00.00	Systems engineering	15.712					15.712	23.083	6.610	45.405
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.535	2.188		2.723	38.789		41.512
03.03.02.01	Motor case and propellant			30.448	20.966		51.414	1237.790		1289.204
03.03.02.02	Nozzle			9.377	5.167		14.544	331.379		345.923
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.394	1.634		2.028	91.673		93.701
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.909	.782		1.691	50.804		52.495
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.473	1.712		4.185	107.242		111.427
03.03.02.06	Thrust termination			.212	.518		.730	33.315		34.045
03.03.02.07	Structures			4.254	8.282		12.536	400.379		412.915
03.03.02.00	Subtotal SRM structures			48.067	39.061		87.128	2252.582		2339.710
03.03.00.00	Subtotal SRM aerospace vehicle equipment			48.602	41.249		89.851	2291.371		2381.222
03.04.00.00	Facilities (activation)				2.637		2.637			2.637
03.05.00.00	System support			.872	3.024	7.311	11.207	254.419	109.463	375.089
03.06.00.00	Ground test	8.464	29.021	9.319			46.804			46.804
03.07.00.00	Flight operations				3.604		3.604		62.662	66.266
03.00.00.00	Total program	37.977	29.021	58.793	50.514	7.311	183.616	2598.931	178.735	2961.282

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1970 DOLLARS IN MILLIONS

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

SMALL ORBITER
CONFIGURATION S4-1208
PEAK LAUNCH RATE: 20/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	16.068					16.068	53.035		69.103
03.02.00.00	Systems engineering	9.503					9.503	18.063	6.490	34.056
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.943	2.491		3.434	43.965		47.399
03.03.02.01	Motor case and propellant			13.394	23.536		36.930	646.868		683.798
03.03.02.02	Nozzle			6.340	6.110		12.450	166.962		179.412
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.231	2.071		2.302	63.772		66.074
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			.731	1.363		2.094	43.163		45.257
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.253	3.306		5.559	97.311		102.870
03.03.02.06	Thrust termination			.217	.766		.983	23.554		24.537
03.03.02.07	Structures			2.925	8.359		11.284	220.404		231.688
03.03.02.00	Subtotal SRM structures			26.091	45.511		71.602	1262.034		1333.636
03.03.00.00	Subtotal SRM aerospace vehicle equipment			27.034	48.002		75.036	1305.999		1381.035
03.04.00.00	Facilities (activation)				3.147		3.147			3.147
03.05.00.00	System support			.735	2.159	7.382	10.276	178.455	77.450	266.181
03.06.00.00	Ground test	2.658	4.036	5.701			12.395			12.395
03.07.00.00	Flight operations				5.557		5.557		56.767	62.324
03.00.00.00	Total program	28.229	4.036	33.470	58.865	7.382	131.982	1555.552	140.707	1828.241

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1970 DOLLARS IN MILLIONS

TABLE 1 SRM BOOSTER STAGE PROGRAM COST ESTIMATE

SMALL ORBITER
CONFIGURATION S4-1208
PEAK LAUNCH RATE: 60/YR.

Task/Subtask	Task Description	Design, Development, Test, and Evaluation						Production	Operations	Total Program
		Engineering Design and Development	Tooling	Ground Test Hardware	Flight Test Hardware	Other	Total			
03.01.00.00	Program management	16.068					16.068	55.387		71.455
03.02.00.00	Systems engineering	9.503					9.503	34.272	8.683	52.458
	Aerospace vehicle equipment									
03.03.01.00	Cluster/interstage SRM structure			.943	2.491		3.434	87.855		91.289
03.03.02.01	Motor case and propellant			13.394	23.536		36.930	1385.593		1422.523
03.03.02.02	Nozzle			6.340	6.110		12.450	359.292		371.742
03.03.02.03	Ordnance (ignition, staging, safe and arm, and thrust termination)			.231	2.071		2.302	132.005		134.307
03.03.02.04	Electrical/instrumentation (cables, distribution box, and switch)			731	1.363		2.094	92.103		94.197
03.03.02.05	Thrust vector control (actuators and auxiliary power unit)			2.253	3.306		5.559	207.285		212.844
03.03.02.06	Thrust termination			.217	.766		.983	50.453		51.436
03.03.02.07	Structures			2.925	8.359		11.284	417.835		429.119
03.03.02.00	Subtotal SRM structures			26.091	45.511		71.602	2644.566		2716.168
03.03.00.00	Subtotal SRM aerospace vehicle equipment			27.034	48.002		75.036	2732.421		2807.457
03.04.00.00	Facilities (activation)				3.147		3.147			3.147
03.05.00.00	System support			.735	2.159	7.382	10.276	368.098	118.931	497.305
03.06.00.00	Ground test	2.658	4.036	5.701			12.395			12.395
03.07.00.00	Flight operations				5.557		5.557		117.250	122.807
03.00.00.00	Total program	28.229	4.036	33.470	58.865	7.382	131.982	3190.178	244.864	3567.024

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